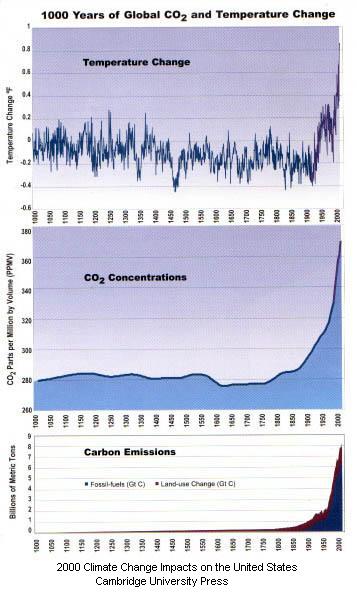
**Top Ten Things You Need to Know about Global Warming**

**There are a number of widely held misconceptions about climate change, and unfortunately, these are reflected in some of the educational materials available on the web. It is therefore crucial for teachers to educate themselves and their students with accurate information and be careful not to reinforce common but incorrect notions. The following primer is a good place to begin.**

**#1 Global warming is caused primarily by carbon dioxide from burning coal, oil and gas.  
Certain gases that trap heat are building up in Earth's atmosphere. The primary culprit is carbon dioxide, released from burning coal, oil and natural gas in power plants, cars, factories, etc. (and to a lesser extent when forests are cleared). The second is methane, released from rice paddies, both ends of cows, rotting garbage in landfills, mining operations, and gas pipelines. Third are chlorofluorocarbons (CFCs) and similar chemicals, which are also implicated in the separate problem of ozone depletion (see #5 below). Nitrous oxide (from fertilizers and other chemicals) is fourth.**

**#2 Earth's average temperature has risen about 1 degree F in the past 100 years and is projected to rise another 3 to 10 degrees F in the next 100 years.  
While Earth's climate has changed naturally throughout time, the current rate of change due to human activity is unprecedented during at least the last 10,000 years. The projected range of temperature rise is wide because it includes a variety of possible future conditions, such as whether or not we control greenhouse gas emissions and different ways the climate system might respond. Temperatures over the US are expected to rise more than over the globe as a whole because land areas closer to the poles are projected to warm faster than those nearer the equator.**

**#3 There is scientific consensus that global warming is real, is caused by human activities, and presents serious challenges.  
Scientists working on this issue report that the observed global warming cannot be explained by natural variations such as changes in the sun's output or volcanic eruptions. The most authoritative source of information is the UN Intergovernmental Panel on Climate Change (**[**IPCC**](http://www.gcrio.org/ipcc_docs.html)**) which draws upon the collective wisdom of many hundreds of scientists from around the world. The IPCC projects global temperature increases of 3 to 10 degrees F in the next 100 years and says that human activity is the cause of most of the observed and projected warming.**

**#4 There's a difference between weather and climate.  
Weather refers to the conditions at one particular time and place, and can change from hour to hour, day to day, and season to season. Climate, on the other hand, refers to the long-term average pattern of weather in a place. For example, we might say that the climate of South Florida is warm, moist and sunny, although the weather on a particular day could be quite different than that. Long-term data are needed to determine changes in climate, and such data indicate that Earth's climate has been warming at a rapid rate since the start of intensive use of coal and oil in the late 1800s.**

**#5 The ozone hole does not cause global warming.  
Ozone depletion is a different problem, caused mainly by CFCs (like Freon) once used in refrigerators and air conditioners. In the past, CFCs were also used in aerosol spray cans, but that use was banned in the US in 1978. CFCs deplete the stratospheric ozone layer that protects life on Earth from excess ultraviolet light that can cause skin cancer and cataracts in humans and other damage to plants and animals. An international agreement has phased out most uses of CFCs but the ozone layer is only just beginning to recover, partly because these chemicals remain in the atmosphere for a long time. (Although ozone depletion is not the cause of global warming, there are a number of connections between the two. For example, many ozone-depleting compounds are also greenhouse gases. Some of the compounds now replacing CFCs in order to protect ozone are also greenhouse gases. And ozone itself is a greenhouse gas. In addition, while greenhouse gas build-up causes temperatures close to Earth's surface to rise, it cause temperatures higher up, in the stratosphere, to fall. This stratospheric cooling speeds ozone depletion, delaying the recovery of the ozone hole.)**

**#6 Global warming will have significant impacts on people and nature.  
As temperatures continue to rise, precipitation is projected to come more frequently in the form of heavy downpours. We can probably expect more extreme wet and dry conditions. In the western US, where snowpack provides free storage of most of the water supply, reduced snowpack will make less water available in summer. Coastal areas will become more vulnerable to storm surges as sea level rises. Plant and animal species will migrate or disappear in response to changes in climate; New England may lose its lobsters and maple trees as they move north into Canada. Natural ecosystems such as coral reefs, mangrove swamps, arctic tundra, and alpine meadows are especially vulnerable and may disappear entirely in some areas. While global warming will have impacts on natural and human systems all around the world, the largest impacts will be on many natural ecosystems and on people who live in developing countries and have few resources and little ability to adapt. On the positive side, warmer winters will reduce cold-related stresses and growing seasons will lengthen. And there will be tradeoffs in some areas, such as less skiing but more hiking; and fewer killing frosts but more bugs.**

**#7 Sea level has already risen due to warming and is projected to rise much more.  
Many people are under the mistaken impression that only if the polar ice caps melt will sea level rise. In fact, average sea level around the world has already risen 4 to 8 inches in the past 100 years due to global warming and is expected to rise another 4 to 35 inches (with a best guess of around 19 inches) by 2100. The primary reason for this rise is that water expands as it warms. The second reason is that glaciers all over the world are melting, and when land-based ice melts, the water runs to the sea and increases its level. Thousands of small islands are threatened by the projected sea-level rise for the 21st century, as are low-lying coastal areas such as southern Florida. Of course, if there is any significant melting of the polar ice sheets, the additional rise in sea level would be enormous (measured in feet not inches). This is projected to occur on a time scale of millennia rather than centuries.**

**#8 Saving energy and developing alternative energy sources would help.  
Each of us can reduce our contribution to global warming by using less greenhouse-gas-producing energy: driving less, choosing fuel efficient cars and appliances (like refrigerators and water heaters), and using solar energy where feasible for water and space heat. We can encourage our political and business leaders to institute policies that will save energy and develop alternative energy sources that do not release carbon dioxide. We can preserve existing forests and plant new ones. But even if we take aggressive action now, we cannot completely prevent climate change because once carbon dioxide is in the atmosphere, it remains there for about a century, and the climate system takes a long time to respond to changes. But our actions now and in the coming decades will have enormous implications for future generations.**

**#9 An international agreement known as the Kyoto Protocol has been negotiated to reduce greenhouse gas emissions, but the US is not participating in it.  
Because of its high energy consumption, the US has long emitted more carbon dioxide than any other country. Because carbon dioxide remains in the atmosphere for about 120 years, it accumulates, becomes equally distributed around the world, and has global effects. Thus, while using large amounts of energy to achieve economic growth, the US and other wealthy nations have unintentionally burdened the rest of the world with a long-term problem. And many negative impacts of climate change are likely to be more severe for poorer countries that lack the resources to adapt. The US has more technological and financial resources than other nations. The role of the US in reducing its own emissions and sharing its technologies with other nations will thus be critical to the success of international efforts to limit climate change. Meanwhile, we do not have to wait for the government to take action. Some companies, governments and individuals have already committed to reducing their emissions of greenhouse gases without laws or treaties requiring them to do so.**

**#10 Protecting the world's climate by stabilizing atmospheric concentrations of greenhouse gases will require enormous reductions in current emissions.  
Even if ratified, the Kyoto Protocol in its present form is only a start and would not be nearly enough to stabilize climate. It is estimated that greenhouse gas emissions would have to be reduced to less than one third of current levels to stabilize atmospheric concentrations. This would require a major transformation of the energy sector. A mix of new and existing energy technologies will be needed to achieve this, including large increases in energy efficiency and renewable energy. Researchers are also developing technology to capture and bury carbon dioxide thousands of feet underground. Major increases in public and private research and development are needed to make the necessary technologies available as rapidly and economically as possible.**

**Why So Much Controversy?**

**With such strong scientific consensus that global warming is real and is largely due to human activities, why is there so much controversy in the press and among the public? Why do some people keep insisting it is just an unproven theory? Some reasons involve communication breakdowns, but even more important is the deliberate campaign by special interests, including some in the fossil fuel industry, to undermine or cast doubt on the science.**

**Climate science can be confusing and is not easily explained in sound bites or brief newspaper articles. Many well-intentioned reporters are ill equipped to get the story right and their mistakes are often perpetuated as other reporters use previous articles as source material for new ones. Partly as a result of such problems, many people erroneously believe that global warming is caused by increased heat entering the atmosphere due to ozone depletion caused by CFCs.**

**In addition, most scientists discuss their research in terms that the public cannot easily understand. They also use some words that mean different things to a lay audience than they do to scientists. For example, when scientists speak of "aerosols," they are referring to tiny atmospheric particles, while to lay people, an "aerosol" is a spray can.**

**But the most significant reason for the controversy is that some special interests have mounted an active campaign to raise doubts and create confusion about this issue. For legitimate and other reasons, a very small number of scientists raise questions about whether warming has or will occur. When they do, special interests work hard to amplify and distribute the views of these "contrarians" in order to create confusion among the press, policymakers and public and give the impression that there is still a major scientific debate about the reality and causes of climate change. (Note: not all fossil fuel companies are implicated in this disinformation campaign. Some, in fact, have acknowledged the scientific realities and are taking steps to reduce their greenhouse gas emissions [see a list of such companies at the Pew Center on Global Climate Change]).**

**Given all this confusion and controversy, it is particularly important that teachers and students have access to reliable information about climate change. It is our hope that this teachers guide will be of some assistance toward that end.**

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**TOP TEN THINGS YOU NEED TO KNOW ABOUT GLOBAL WARMING**

ONE

1. What is the primary cause of global warming? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What gases trap heat in the atmosphere and where are they commonly found? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

TWO

1. How much has Earth’s temperature risen in the past 100 years? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the temperature projected to rise in the next 100 years? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What possible future conditions effect the projected range of temperatures? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Where are temperatures expected to rise the most? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

THREE

1. What 2 natural variations have scientists reported as not being the cause for global warming? \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the most authoritative source for information on this topic? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What does it project for temperatures in the next 100 years? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

FOUR

1. What is the difference between weather and climate? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. When does the long term data indicate the warming trend began? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

FIVE

1. What causes ozone depletion? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Where is this substance found? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What are 2 problems associated with excess ultraviolet light? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

SIX

1. If global warming will cause more downpours, why will the western US have water shortages in the summer? \_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What will happen to coastal areas? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What will happen to some species in New England? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. What natural ecosystems are especially vulnerable? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. List 2 possible positive effects of global warming? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. What are 2 possible tradeoffs? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

SEVEN

1. How much has average sea level risen in the past 100 years? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. How much expected by 2100? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. List 2 reasons for this rise? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. What would happen if the polar ice sheets melt? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

EIGHT

1. What are 5 ways we can reduce our contribution to global warming? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

NINE

1. What international agreement was negotiated to reduce greenhouse gas emissions? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What major country did not participate? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. How long does carbon dioxide remain in the atmosphere? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

TEN

1. To stabilize atmospheric concentrations of greenhouse gas emissions, how much would we need to reduce levels? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Summarize reasons for the controversy. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_